

UNIT 12: THE RESPIRATORY SYSTEM

Pleasant Valley High School
Anatomy and Physiology

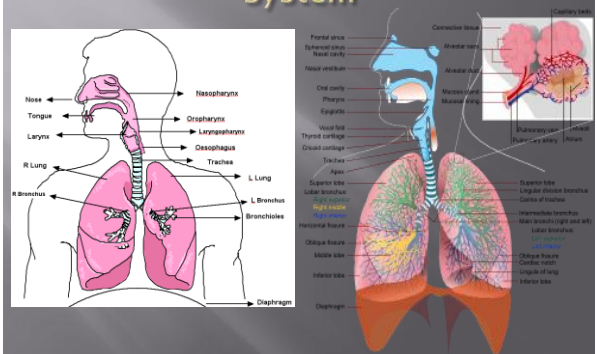
16.1 Introduction

- Purpose of the Respiratory System
 - Filters and warms
 - Humidifies
 - Helps with olfaction (smell)
 - Air distribution
 - Gas Exchange

Events of Respiration

- Movement of air into and out of the lungs
- Gas exchange between blood and air in the lungs
- Gas transport between the lungs and blood and the body cells
- Gas exchange between the blood and body cells
 - Cellular Respiration - the oxygen utilization and carbon dioxide production at the cellular level

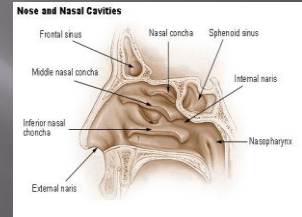
Structure of the Respiratory System



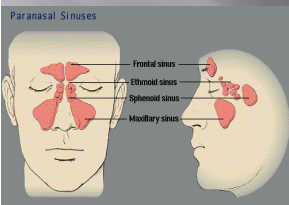
16.2 Organs of the Respiratory System

- ❑ Bone and cartilage
- ❑ Two nostrils with many hairs
- ❑ Nasal Cavity
 - Hollow space behind the nose
 - Nasal septum – splits the nostrils
 - Nasal conchae – bones that curl from the lateral walls

The Nose



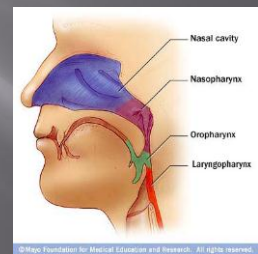
Paranasal Sinuses



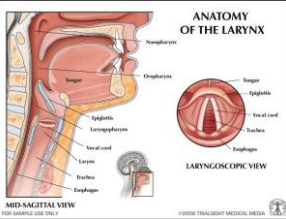
- ❑ Air filled spaces located within:
 - Maxillary
 - Frontal
 - Ethmoid
 - Sphenoid
- ❑ Mucous membranes line sinuses
- ❑ Resonance chambers that affect the voice quality

Pharynx

- ❑ Fancy name for the throat
- ❑ Passageway for air passing from the nasal cavity to the larynx
- ❑ Produces speech sound
- ❑ Note the 4 regions of the pharynx

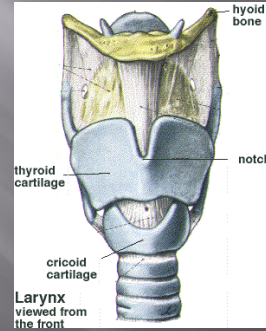


Larynx



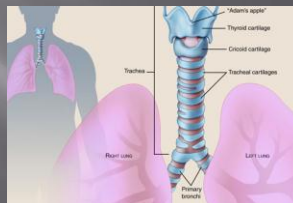
- ❑ An enlargement in the airway at the top of the trachea
- ❑ Framework of cartilage and muscles
 - Thyroid Cartilage (Adam's Apple)
 - Cricoid
 - Epiglottic
- ❑ Two pairs of horizontal folds of muscle
 - *False Vocal Cords* - the upper set of muscles, do not produce sound
 - *True Vocal Cords* - air forced here produces sound
 - *Glottis* - triangular slit between the vocal cords, open during speech, closed during eating

Cartilage of the Larynx

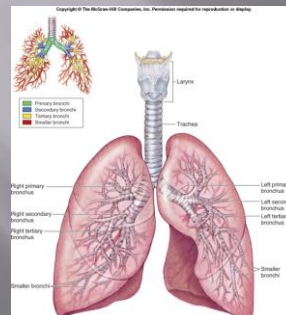


Trachea

- ❑ The windpipe
- ❑ Flexible tube, 2.5 cm in diameter, 12.5 cm in length
- ❑ Splits into the right and left bronchi
- ❑ Ciliated mucous membrane lines the trachea's inner wall
- ❑ About 20 C-shaped cartilage bands within the wall of the trachea
 - Prevents collapse of the trachea, thus preventing suffocation
 - The back of the trachea is soft, as to allow the esophagus to perform peristalsis



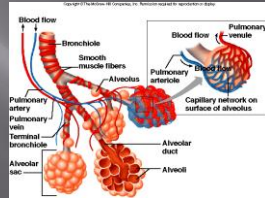
Bronchial Tree



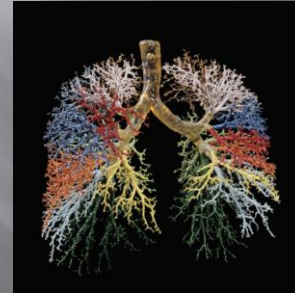
- ❑ Branched airways leading from the trachea to the air sacs of the lungs
- ❑ Branches begin with primary bronchi (right and left)
 - Divide into secondary bronchi
 - Divide into tertiary bronchi
 - Bronchioles - smaller tubes, see next slide

Bronchioles

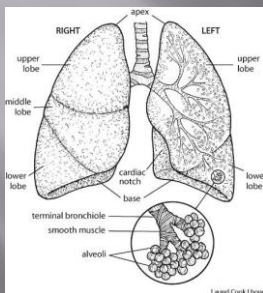
- Small tubes that branch from bronchi
 - Give rise to *alveolar ducts*
 - These ducts lead to *alveolar sacs*, thin walled pouches at the end of bronchi
 - These sacs are made of microscopic air sacs called *alveoli*, which lie within a capillary network



The Lungs



Lungs



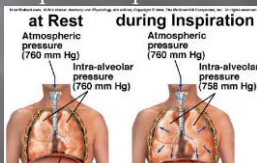
- Soft, spongy, cone shaped
- Occupies most of the space in the thoracic cavity, suspended by the bronchi and some vessels
- Attached by the *visceral pleura* and *parietal pleura*
- Virtually no space exists between the visceral and parietal pleura, but the potential space is called *pleural cavity*
- Know the structure of the lungs
 - Note that the left lung has 2 lobes, and the right has 3
 - Left lung is notched to rest the heart

16.3 Breathing Mechanism

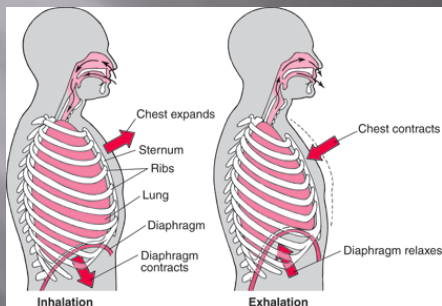
Inspiration and Expiration

Inspiration

- Atmospheric pressure due to the weight of air is the force that moves air into the lungs
- Air pressure is exerted on all surfaces it contacts
- When air pressure decreases in the lungs, atmospheric pressure pushes more air in

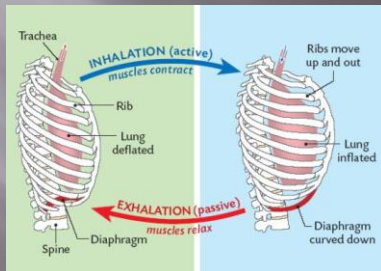


- The diaphragm is contracted by the phrenic nerves sending impulses to the cervical plexus
- The diaphragm lowers, and the pressure in the alveoli drops from 760 mmHg to 758 mmHg
- The *external intercostal muscles* also contract and cause the sternum to elevate allowing more space in the thoracic cavity for the lungs to expand into
- If moisture reaches the alveoli, *surface tension* makes expansion difficult and could cause collapse
- Surfactants – a mixture of lipoproteins that are continuously being secreted into the alveoli from certain alveolar cells that prevents the tendency of the alveoli to collapse



Expiration

- The elastic tissue in the lungs and thoracic cavity are activated
- The diaphragm lowers and compresses the abdominal organs
- Normal expiration is a passive process, it's just the body returning to its resting state
- Active Expiration occurs during "deep breaths" ...activation of the *internal intercostal muscles* and the *abdominal wall muscles* causes an extra push moving more air out of the lungs



Air Volume and Capacity

- ❑ *Spirometry* - the measure of respiratory volumes
- ❑ One inspiration and the resulting expiration is one respiratory cycle
- ❑ The volume of air that enters or leaves during a respiratory cycle is called *tidal volume*
- ❑ About 500 mL enters/leaves during normal respiration (*resting tidal volume*)
- ❑ During a forced inspiration, air in addition to the tidal volume enters the lungs (*inspiratory reserve volume*) and at maximum equals 3000mL
- ❑ During forced expiration, the lungs can expel up to 1,100mL of air beyond tidal volume (*expiratory reserve volume*)
- ❑ Even after a forced expiration, around 1,200mL of air still remains in the lungs to keep them inflated at all times (*residual volume*)

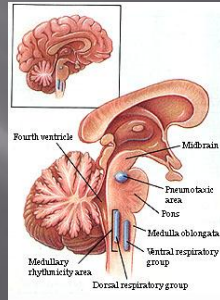
Respiratory Capacities

- ❑ Combining two or more respiratory volumes yields 4 respiratory capacities
 - **Vital Capacity** - combination of inspiratory reserve volume (3,000mL) and tidal volume (500mL) and expiratory reserve volume (1,100mL) for a total of 4,600mL...the maximum amount of air that a person can exhale following the deepest breath possible
 - **Inspiratory Capacity** - tidal volume + inspiratory reserve volume, (3,500mL), maximum volume that can be inhaled following a resting expiration
 - **Functional Residual Capacity** - expiratory reserve volume + residual volume (2,300mL), volume of air that remains after a resting expiration
 - **Total Lung Capacity** - vital capacity + residual volume = 5,800 mL
 - ❑ Can vary with age, sex, and body size
 - ❑ About 150mL, never reaches the alveoli, it remains in the channels of the trachea, bronchi and bronchioles
 - This space is said to be *anatomic dead space*

16.4 Breathing Control

The Respiratory Center

- Groups of neurons in the brain stem
- *Medullary rhythmicity area* - two neuron groups (ventral and dorsal respiratory groups) extending the length of the medulla oblongata
- *Pneumotaxic Area* - transmits impulses that prevents inspiratory bursts originating from the dorsal group
 - *If a burst occurs, breathing rate decreases*

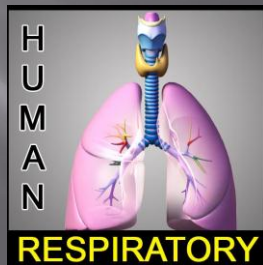


Factors Affecting Breathing

- Know the content of this section

Time for Check-Your-Recall

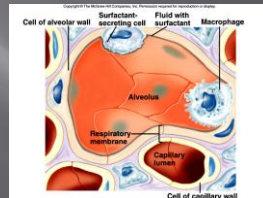
- Answer all check your recall questions from this chapter to this point
 - Pgs 435 - 449



16.5 Alveolar Gas Exchanges

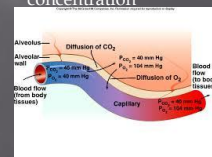
Respiratory Membrane

- The wall of the alveolus consists of an inner lining of simple squamous epithelium and capillaries
- At least two thicknesses of epithelial cells and a layer of basement cells separate blood from air
- These layers make up the respiratory membrane



Diffusion Across the Membrane

- Since air is 78% nitrogen, 21% oxygen, and .04% carbon dioxide, no one gas accounts for the total air pressure, thus each gas has a *partial pressure* for which it is responsible
- To calculate partial pressure just find a proportion of the percentage of air concentration to total air pressure
- Due to these differences in concentration and pressure, air travels due to its ability to diffuse across a membrane
 - Remember diffusion occurs from area of high concentration to an area of low concentration



16.6 Gas Transport

Oxygen Transport

- 98% of oxygen that blood transports combines with hemoglobin in RBC, the other 2% dissolves in plasma
- In the lungs, the P_{O_2} is high, here oxygen dissolves into the blood and combines quickly with hemoglobin forming *oxyhemoglobin*, a very unstable molecule, it quickly releases oxygen which diffuses into nearby cells with oxygen depletions from cellular respiration
 - More oxygen is released when:
 - Carbon dioxide concentration increases
 - Blood becomes acidic
 - Blood temperature increases
 - Hypoxia: deficiency of O₂ in tissues, know the different varieties

Carbon Dioxide Transport

- ▣ Tissues have a high concentration of carbon dioxide
- ▣ Blood transports carbon dioxide to the lungs in one of three forms
 - Carbon dioxide dissolved in plasma
 - Compound bound to hemoglobin
 - Bicarbonate ion
- ▣ Carbon dioxide bonds with amino groups of the globin protein of hemoglobin
 - Carbaminohemoglobin – molecule formed by CO₂ binding to hemoglobin, decomposes in low CO₂ concentrations, only 23% of CO₂ in the blood travels this way
- ▣ Bicarbonate ions – most important method of CO₂ transport, results from carbonic anhydrase reacting in the red blood cells forming carbonic acid that quickly breaks into hydrogen and bicarbonate